

CLAIMS

What is claimed is:

5     1. A method for managing Internet Protocol (IP) addresses on a data communications network, comprising:  
allocating a plurality of local IP address pools, each of said local IP address pools associated with a different network edge device capable of accepting connection requests requiring an IP address, said network edge device having a local  
10    memory, said local memory including a local IP address pool database;  
requesting IP address usage data from one or more of said network edge devices;  
receiving said requested IP address usage data;  
determining whether one or more of said plurality of local IP address pools should be reallocated based upon at least said requested IP address usage data;  
15    reallocating one or more of said plurality of local IP address pools based upon said determining; and  
updating one or more of said local IP address pool databases and a global IP pool database based upon said reallocating, said global IP address pool database including the information maintained in each said local IP address pool.

20    2. The method of claim 1 wherein  
said local IP address pool includes a high watermark that indicates the maximum number of IP addresses used by said network edge device;

5 said determining further comprises ascertaining whether said high watermark of a local address pool exceeds a high watermark limit; and

10 said method further comprises indicating one or more IP address pools should be reallocated to give more IP addresses to the network element associated with said high watermark when said high watermark exceeds said high watermark limit.

3. The method of claim 2 wherein

15 each said local IP address pool further comprises a low watermark that indicates the minimum number of IP addresses used by said network edge device;

20 said determining further comprises ascertaining whether said low watermark of said address pool exceeds a low watermark limit; and

25 said method further comprises indicating one or more IP address pools should be reallocated to reclaim IP addresses from the network element associated with said low watermark when said low watermark exceeds said low watermark limit.

4. The method of claim 3 wherein said reallocating further comprises:

30 allocating an IP address from IP addresses reclaimed from other IP address pools

when said high watermark exceeds said high watermark limit and when the number of unallocated IP addresses is insufficient;

35 allocating an IP addresses from unallocated IP addresses when said high watermark exceeds said high watermark limit and when the number of unallocated IP addresses is sufficient; and

reallocating one or more IP address pools to reclaim IP addresses from a local IP address pool when said high watermark is less than said high watermark limit and said low watermark is greater than said low watermark limit.

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5. The method of claim 1 wherein

each said local IP address pool further comprises a low watermark that indicates the

minimum number of IP addresses used by said network edge device;

said determining further comprises ascertaining whether said low watermark of said

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address pool exceeds a low watermark limit; and

said method further comprises indicating one or more IP address pools should be

reallocated to reclaim IP addresses from the network element associated with

said low watermark when said low watermark exceeds said low watermark limit.

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6. The method of claim 3 wherein

said low watermark is expressed as a percentage of allocated IP addresses; and

said high watermark is expressed as a percentage of allocated IP addresses.

7. The method of claim 6 wherein said network operates according to a simple network

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management protocol (SNMP).

8. The method of claim 7 wherein

said low watermark is stored in an expression MIB; and

said high watermark is stored in an expression MIB.

9. A method for managing Internet Protocol (IP) addresses on a data communications network, comprising:

5       allocating a plurality of local IP address pools, each of said local IP address pools associated with a different network edge device capable of accepting connection requests requiring an IP address, said network edge device having a local memory, said local memory including a local IP address pool database; receiving a communication from said network edge device, said communication 10      including an IP address usage summary; determining whether one or more of said plurality of local IP address pools should be adjusted based upon said IP address usage summary; and adjusting one or more of said plurality of local IP address pools based upon said determining.

15      10. The method of claim 9 wherein:

      said local IP address pool includes a high watermark that indicates the maximum number of IP addresses used by said network edge device; said determining further comprises ascertaining whether said high watermark of a 20      local address pool exceeds a high watermark limit; and said method further comprises indicating one or more IP address pools should be reallocated to give more IP addresses to the network element associated with said high watermark when said high watermark exceeds said high watermark limit.

11. The method of claim 10 wherein

each said local IP address pool further comprises a low watermark that indicates the

minimum number of IP addresses used by said network edge device;

5 said determining further comprises ascertaining whether said low watermark of a said address pool exceeds a low watermark limit; and

said method further comprises indicating one or more IP address pools should be

reallocated to reclaim IP addresses from the network element associated with

said low watermark when said low watermark exceeds said low watermark limit.

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12. The method of claim 11 wherein said reallocating further comprises:

allocating an IP address from IP addresses reclaimed from other IP address pools

when said high watermark exceeds said high watermark limit and when the

number of unallocated IP addresses is insufficient;

15 allocating an IP addresses from unallocated IP addresses when said high watermark

exceeds said high watermark limit and when the number of unallocated IP

addresses is sufficient; and

reallocating one or more IP address pools to reclaim IP addresses from a local IP

address pool when said high watermark is less than said high watermark limit

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and said low watermark is greater than said low watermark limit.

13. The method of claim 9 wherein

each said local IP address pool further comprises a low watermark that indicates the

minimum number of IP addresses used by said network edge device;

5 said determining further comprises ascertaining whether said low watermark of said address pool exceeds a low watermark limit; and  
said method further comprises indicating one or more IP address pools should be  
reallocated to reclaim IP addresses from the network element associated with  
said low watermark when said low watermark exceeds said low watermark limit.

14. The method of claim 11 wherein

10 said low watermark is expressed as a percentage of allocated IP addresses; and  
said high watermark is expressed as a percentage of allocated IP addresses.

15. The method of claim 14 wherein said network operates according to a simple network  
management protocol (SNMP).

15 16. The method of claim 15 wherein

said low watermark is stored in an expression MIB; and  
said high watermark is stored in an expression MIB.

17. A method for managing Internet Protocol (IP) addresses on a data communications

20 network, comprising:

receiving a communication;  
allocating an available IP address from said local IP address pool if said  
communication includes a connection request, said local IP address pool  
associated with a different network edge device capable of accepting connection  
25 requests;

determining whether said local IP address pool should be adjusted;  
sending a alarm message to an IP pool manager when said IP address pool should be  
adjusted; and  
5 storing an IP address allocation when said communication includes an IP address  
allocation.

18. The method of claim 17 wherein

said local IP address pool includes a high watermark that indicates the maximum  
10 number of IP addresses used by said network edge device; and  
said determining further comprises:  
ascertaining whether said high watermark of a local address pool exceeds a high  
watermark limit; and  
indicating one or more IP address pools should be reallocated to give more IP  
15 addresses to said network edge device when said high watermark exceeds  
said high watermark limit.

19. The method of claim 18 wherein

each said local IP address pool further comprises a low watermark that indicates the  
20 minimum number of IP addresses used by said network edge device; and  
said determining further comprises:  
ascertaining whether said low watermark of said address pool exceeds a low  
watermark limit; and

said method further comprises indicating one or more IP address pools should be reallocated to reclaim IP addresses from said network edge device when said low watermark exceeds said low watermark limit.

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20. The method of claim 19 wherein said reallocating further comprises:

allocating an IP address from IP addresses reclaimed from other IP address pools when said high watermark exceeds said high watermark limit and when the number of unallocated IP addresses is insufficient;

10 allocating an IP addresses from unallocated IP addresses when said high watermark exceeds said high watermark limit and when the number of unallocated IP addresses is sufficient; and

reallocating one or more IP address pools to reclaim IP addresses from said local IP address pool when said high watermark is less than said high watermark limit and said low watermark is greater than said low watermark limit.

15 21. The method of claim 17 wherein

each said local IP address pool further comprises a low watermark that indicates the minimum number of IP addresses used by said network edge device; and

20 said determining further comprises:

ascertaining whether said low watermark of said local address pool exceeds a low watermark limit; and

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indicating one or more IP address pools should be reallocated to reclaim IP addresses from the network element associated with said low watermark when said low watermark exceeds said low watermark limit.

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22. The method of claim 19 wherein

said low watermark is expressed as a percentage of allocated IP addresses; and  
said high watermark is expressed as a percentage of allocated IP addresses.

10 23. The method of claim 22 wherein said network operates according to a simple network management protocol (SNMP).

24. The method of claim 23 wherein

said low watermark is stored in an expression MIB; and  
15 said high watermark is stored in an expression MIB.

25. A program storage device readable by a machine, embodying a program of instructions executable by the machine to perform a method to manage Internet Protocol (IP) addresses on a data communications network, the method comprising:  
20 allocating a plurality of local IP address pools, each of said local IP address pools associated with a different network edge device capable of accepting connection requests requiring an IP address, said network edge device having a local memory, said local memory including a local IP address pool database;  
requesting IP address usage data from one or more of said network edge devices;  
25 receiving said requested IP address usage data;

determining whether one or more of said plurality of local IP address pools should be reallocated based upon at least said requested IP address usage data;

reallocating one or more of said plurality of local IP address pools based upon said

5 determining; and

updating one or more of said local IP address pool databases and a global IP pool

database based upon said reallocating, said global IP address pool database

including the information maintained in each said local IP address pool.

10 26. The program storage device of claim 25 wherein

said local IP address pool includes a high watermark that indicates the maximum number of IP addresses used by said network edge device;

said determining further comprises ascertaining whether said high watermark of a local address pool exceeds a high watermark limit; and

15 said method further comprises indicating one or more IP address pools should be reallocated to give more IP addresses to the network element associated with said high watermark when said high watermark exceeds said high watermark limit.

27. The program storage device of claim 26 wherein

20 each said local IP address pool further comprises a low watermark that indicates the minimum number of IP addresses used by said network edge device;

said determining further comprises ascertaining whether said low watermark of said address pool exceeds a low watermark limit; and

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said method further comprises indicating one or more IP address pools should be reallocated to reclaim IP addresses from the network element associated with said low watermark when said low watermark exceeds said low watermark limit.

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28. The program storage device of claim 27 wherein said reallocating further comprises: allocating an IP address from IP addresses reclaimed from other IP address pools when said high watermark exceeds said high watermark limit and when the number of unallocated IP addresses is insufficient;

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allocating an IP addresses from unallocated IP addresses when said high watermark exceeds said high watermark limit and when the number of unallocated IP addresses is sufficient; and

reallocating one or more IP address pools to reclaim IP addresses from a local IP address pool when said high watermark is less than said high watermark limit and said low watermark is greater than said low watermark limit.

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29. The program storage device of claim 25 wherein

each said local IP address pool further comprises a low watermark that indicates the minimum number of IP addresses used by said network edge device;

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said determining further comprises ascertaining whether said low watermark of said address pool exceeds a low watermark limit; and

said method further comprises indicating one or more IP address pools should be reallocated to reclaim IP addresses from the network element associated with said low watermark when said low watermark exceeds said low watermark limit.

30. The program storage device of claim 27 wherein  
said low watermark is expressed as a percentage of allocated IP addresses; and  
5 said high watermark is expressed as a percentage of allocated IP addresses.

31. The program storage device of claim 30 wherein said network operates according to a  
simple network management protocol (SNMP).

10 32. The program storage device of claim 31 wherein  
said low watermark is stored in an expression MIB; and  
said high watermark is stored in an expression MIB.

33. A program storage device readable by a machine, embodying a program of  
instructions executable by the machine to perform a method to manage Internet  
Protocol (IP) addresses on a data communications network, the method comprising:  
15 allocating a plurality of local IP address pools, each of said local IP address pools  
associated with a different network edge device capable of accepting connection  
requests requiring an IP address, said network edge device having a local  
20 memory, said local memory including a local IP address pool database;  
receiving a communication from said network edge device, said communication  
including an IP address usage summary;  
determining whether one or more of said plurality of local IP address pools should be  
adjusted based upon said IP address usage summary; and

adjusting one or more of said plurality of local IP address pools based upon said determining.

5 34. The program storage device of claim 33 wherein:

said local IP address pool includes a high watermark that indicates the maximum number of IP addresses used by said network edge device;

said determining further comprises ascertaining whether said high watermark of a local address pool exceeds a high watermark limit; and

10 said method further comprises indicating one or more IP address pools should be reallocated to give more IP addresses to the network element associated with said high watermark when said high watermark exceeds said high watermark limit.

35. The program storage device of claim 34 wherein

each said local IP address pool further comprises a low watermark that indicates the minimum number of IP addresses used by said network edge device;

said determining further comprises ascertaining whether said low watermark of a said address pool exceeds a low watermark limit; and

said method further comprises indicating one or more IP address pools should be reallocated to reclaim IP addresses from the network element associated with said low watermark when said low watermark exceeds said low watermark limit.

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36. The program storage device of claim 35 wherein said reallocating further comprises:

allocating an IP address from IP addresses reclaimed from other IP address pools

when said high watermark exceeds said high watermark limit and when the

5 number of unallocated IP addresses is insufficient;

allocating an IP addresses from unallocated IP addresses when said high watermark

exceeds said high watermark limit and when the number of unallocated IP

addresses is sufficient; and

reallocating one or more IP address pools to reclaim IP addresses from a local IP

address pool when said high watermark is less than said high watermark limit

and said low watermark is greater than said low watermark limit.

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37. The program storage device of claim 33 wherein

each said local IP address pool further comprises a low watermark that indicates the

minimum number of IP addresses used by said network edge device;

said determining further comprises ascertaining whether said low watermark of said

address pool exceeds a low watermark limit; and

said method further comprises indicating one or more IP address pools should be

reallocated to reclaim IP addresses from the network element associated with

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38. The program storage device of claim 35 wherein

said low watermark is expressed as a percentage of allocated IP addresses; and

said high watermark is expressed as a percentage of allocated IP addresses.

39. The program storage device of claim 38 wherein said network operates according to a simple network management protocol (SNMP).

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40. The program storage device of claim 39 wherein  
said low watermark is stored in an expression MIB; and  
said high watermark is stored in an expression MIB.

10 41. A program storage device readable by a machine, embodying a program of  
instructions executable by the machine to perform a method to manage Internet  
Protocol (IP) addresses on a data communications network, the method comprising:  
receiving a communication;  
allocating an available IP address from said local IP address pool if said  
15 communication includes a connection request, said local IP address pool  
associated with a different network edge device capable of accepting connection  
requests;  
determining whether said local IP address pool should be adjusted;  
sending a alarm message to an IP pool manager when said IP address pool should be  
20 adjusted; and  
storing an IP address allocation when said communication includes an IP address  
allocation.

42. The program storage device of claim 41 wherein  
said local IP address pool includes a high watermark that indicates the maximum  
number of IP addresses used by said network edge device; and  
5 said determining further comprises:  
ascertaining whether said high watermark of a local address pool exceeds a high  
watermark limit; and  
indicating one or more IP address pools should be reallocated to give more IP  
addresses to said network edge device when said high watermark exceeds  
10 said high watermark limit.

43. The program storage device of claim 42 wherein  
each said local IP address pool further comprises a low watermark that indicates the  
minimum number of IP addresses used by said network edge device; and  
15 said determining further comprises:  
ascertaining whether said low watermark of said address pool exceeds a low  
watermark limit; and  
said method further comprises indicating one or more IP address pools should be  
reallocated to reclaim IP addresses from said network edge device when said  
20 low watermark exceeds said low watermark limit.

44. The program storage device of claim 43 wherein said reallocating further comprises:

allocating an IP address from IP addresses reclaimed from other IP address pools

when said high watermark exceeds said high watermark limit and when the

5 number of unallocated IP addresses is insufficient;

allocating an IP addresses from unallocated IP addresses when said high watermark

exceeds said high watermark limit and when the number of unallocated IP

addresses is sufficient; and

reallocating one or more IP address pools to reclaim IP addresses from said local IP

10 address pool when said high watermark is less than said high watermark limit

and said low watermark is greater than said low watermark limit.

45. The program storage device of claim 41 wherein

each said local IP address pool further comprises a low watermark that indicates the

15 minimum number of IP addresses used by said network edge device; and

said determining further comprises:

ascertaining whether said low watermark of said local address pool exceeds a low

watermark limit; and

indicating one or more IP address pools should be reallocated to reclaim IP

20 addresses from the network element associated with said low watermark

when said low watermark exceeds said low watermark limit.

46. The program storage device of claim 43 wherein

said low watermark is expressed as a percentage of allocated IP addresses; and

5 said high watermark is expressed as a percentage of allocated IP addresses.

47. The program storage device of claim 46 wherein said network operates according to a

5 simple network management protocol (SNMP).

48. The program storage device of claim 47 wherein

10 said low watermark is stored in an expression MIB; and

15 said high watermark is stored in an expression MIB.

49. An apparatus for managing Internet Protocol (IP) addresses on a data

communications network, the apparatus comprising:

means for allocating a plurality of local IP address pools, each of said local IP address

15 pools associated with a different network edge device capable of accepting

connection requests requiring an IP address, said network edge device having a

local memory, said local memory including a local IP address pool database;

means for requesting IP address usage data from one or more of said network edge

20 devices;

means for receiving said requested IP address usage data;

means for determining whether one or more of said plurality of local IP address pools

25 should be reallocated based upon at least said requested IP address usage data;

means for reallocating one or more of said plurality of local IP address pools based

upon said determining; and

means for updating one or more of said local IP address pool databases and a global IP pool database based upon said reallocating, said global IP address pool database including the information maintained in each said local IP address pool.

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50. The apparatus of claim 49 wherein

said local IP address pool includes a high watermark that indicates the maximum

number of IP addresses used by said network edge device;

said means for determining further comprises means for ascertaining whether said

high watermark of a local address pool exceeds a high watermark limit; and

said apparatus further comprises means for indicating one or more IP address pools

should be reallocated to give more IP addresses to the network element

associated with said high watermark when said high watermark exceeds said high

watermark limit.

### apparatus of claim

51. The apparatus of claim 50 wherein

each said local IP address pool further comprises a low watermark that indicates the

minimum number of IP addresses used by said network edge device;

said means for determining further comprises means for ascertaining whether said

low watermark of said address pool exceeds a low watermark limit; and

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low watermark of said address pool exceeds a low watermark limit; and

said apparatus further comprises means for indicating one or more IP address pools

should be reallocated to reclaim IP addresses from the network element

associated with said low watermark when said low watermark exceeds said low

watermark limit.

52. The apparatus of claim 51 wherein said reallocating further comprises:

means for allocating an IP address from IP addresses reclaimed from other IP address

5 pools when said high watermark exceeds said high watermark limit and when the number of unallocated IP addresses is insufficient;

means for allocating an IP addresses from unallocated IP addresses when said high

watermark exceeds said high watermark limit and when the number of unallocated IP addresses is sufficient; and

10 means for reallocating one or more IP address pools to reclaim IP addresses from a

local IP address pool when said high watermark is less than said high watermark limit and said low watermark is greater than said low watermark limit.

53. The apparatus of claim 49 wherein

15 each said local IP address pool further comprises a low watermark that indicates the minimum number of IP addresses used by said network edge device;

said means for determining further comprises ascertaining whether said low watermark of said address pool exceeds a low watermark limit; and

said apparatus further comprises means for indicating one or more IP address pools

20 should be reallocated to reclaim IP addresses from the network element

associated with said low watermark when said low watermark exceeds said low watermark limit.

54. The apparatus of claim 51 wherein

said low watermark is expressed as a percentage of allocated IP addresses; and  
said high watermark is expressed as a percentage of allocated IP addresses.

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55. The apparatus of claim 54 wherein said network operates according to a simple network management protocol (SNMP).

56. The apparatus of claim 55 wherein

10 said low watermark is stored in an expression MIB; and  
said high watermark is stored in an expression MIB.

57. An apparatus for managing Internet Protocol (IP) addresses on a data communications network, the apparatus comprising:

means for allocating a plurality of local IP address pools, each of said local IP address pools associated with a different network edge device capable of accepting connection requests requiring an IP address, said network edge device having a local memory, said local memory including a local IP address pool database;

means for receiving a communication from said network edge device, said communication including an IP address usage summary;

means for determining whether one or more of said plurality of local IP address pools should be adjusted based upon said IP address usage summary; and means for adjusting one or more of said plurality of local IP address pools based upon said determining.

58. The apparatus of claim 57 wherein:

5       said local IP address pool includes a high watermark that indicates the maximum  
number of IP addresses used by said network edge device;  
said means for determining further comprises means for ascertaining whether said  
high watermark of a local address pool exceeds a high watermark limit; and  
said apparatus further comprises means for indicating one or more IP address pools  
should be reallocated to give more IP addresses to the network element  
10      associated with said high watermark when said high watermark exceeds said high  
watermark limit.

59. The apparatus of claim 10 wherein

15      each said local IP address pool further comprises a low watermark that indicates the  
minimum number of IP addresses used by said network edge device;  
said means for determining further comprises means for ascertaining whether said  
low watermark of a said address pool exceeds a low watermark limit; and  
said apparatus further comprises means for indicating one or more IP address pools  
should be reallocated to reclaim IP addresses from the network element  
20      associated with said low watermark when said low watermark exceeds said low  
watermark limit.

60. The apparatus of claim 11 wherein said reallocating further comprises:

means for allocating an IP address from IP addresses reclaimed from other IP address pools when said high watermark exceeds said high watermark limit and when the

5 number of unallocated IP addresses is insufficient;

means for allocating an IP addresses from unallocated IP addresses when said high watermark exceeds said high watermark limit and when the number of unallocated IP addresses is sufficient; and

means for reallocating one or more IP address pools to reclaim IP addresses from a

10 local IP address pool when said high watermark is less than said high watermark limit and said low watermark is greater than said low watermark limit.

61. The apparatus of claim 57 wherein

each said local IP address pool further comprises a low watermark that indicates the minimum number of IP addresses used by said network edge device;

15 said means for determining further comprises means for ascertaining whether said low watermark of said address pool exceeds a low watermark limit; and

said apparatus further comprises means for indicating one or more IP address pools should be reallocated to reclaim IP addresses from the network element

20 associated with said low watermark when said low watermark exceeds said low watermark limit.

62. The apparatus of claim 59 wherein

said low watermark is expressed as a percentage of allocated IP addresses; and

5 said high watermark is expressed as a percentage of allocated IP addresses.

63. The apparatus of claim 62 wherein said network operates according to a simple

5 network management protocol (SNMP).

64. The apparatus of claim 63 wherein

10 said low watermark is stored in an expression MIB; and

15 said high watermark is stored in an expression MIB.

65. An apparatus for managing Internet Protocol (IP) addresses on a data

20 communications network, the apparatus comprising:

25 means for receiving a communication;

30 means for allocating an available IP address from a local IP address pool if said

35 communication includes a connection request, said local IP address pool

40 associated with a different network edge device capable of accepting connection

45 requests;

50 means for determining whether said local IP address pool should be adjusted;

55 means for sending a alarm message to a global IP pool manager when said IP address

60 pool should be adjusted; and

65 means for storing an IP address allocation when said communication includes an IP

70 address allocation.

66. The apparatus of claim 65 wherein

    said local IP address pool includes a high watermark that indicates the maximum  
    number of IP addresses used by said network edge device; and

5      said means for determining further comprises:

        means for ascertaining whether said high watermark of a local address pool  
        exceeds a high watermark limit; and

        means for indicating one or more IP address pools should be reallocated to give  
        more IP addresses to said network edge device when said high watermark  
10      exceeds said high watermark limit.

67. The apparatus of claim 66 wherein

    each said local IP address pool further comprises a low watermark that indicates the  
    minimum number of IP addresses used by said network edge device; and

15      said means for determining further comprises:

        means for ascertaining whether said low watermark of said address pool exceeds a  
        low watermark limit; and

        said apparatus further comprises means for indicating one or more IP address  
        pools should be reallocated to reclaim IP addresses from said network edge  
20      device when said low watermark exceeds said low watermark limit.

68. The apparatus of claim 67 wherein said reallocating further comprises:

means for allocating an IP address from IP addresses reclaimed from other IP address pools when said high watermark exceeds said high watermark limit and when the

5 number of unallocated IP addresses is insufficient;

means for allocating an IP addresses from unallocated IP addresses when said high watermark exceeds said high watermark limit and when the number of unallocated IP addresses is sufficient; and

means for reallocating one or more IP address pools to reclaim IP addresses from said 10 local IP address pool when said high watermark is less than said high watermark limit and said low watermark is greater than said low watermark limit.

69. The apparatus of claim 65 wherein

each said local IP address pool further comprises a low watermark that indicates the 15 minimum number of IP addresses used by said network edge device; and

said means for determining further comprises:

means for ascertaining whether said low watermark of said local address pool exceeds a low watermark limit; and

means for indicating one or more IP address pools should be reallocated to 20 reclaim IP addresses from the network element associated with said low watermark when said low watermark exceeds said low watermark limit.

70. The apparatus of claim 67 wherein

said low watermark is expressed as a percentage of allocated IP addresses; and

5 said high watermark is expressed as a percentage of allocated IP addresses.

71. The apparatus of claim 70 wherein said network operates according to a simple

5 network management protocol (SNMP).

72. The apparatus of claim 71 wherein

10 said low watermark is stored in an expression MIB; and

15 said high watermark is stored in an expression MIB.

73. An apparatus capable of managing Internet Protocol (IP) addresses on a data communications network, said apparatus comprising:

20 a memory for storing a global IP address pool; and

25 a global IP pool manager, comprising:

30 an allocator capable of allocating a plurality of local IP address pools, each of said

35 local IP address pools associated with a different network edge device

40 capable of accepting connection requests requiring an IP address;

45 a requestor capable of requesting IP address usage data from one or more of said

50 network edge devices;

55 a determiner capable of determining whether one or more of said plurality of local

60 IP address pools should be reallocated based upon at least said requested IP

65 address usage data;

70 a reallocator capable of reallocating one or more of said plurality of local IP

75 address pools based upon said an indication from said determiner; and

an updaters capable of updating one or more of said local IP address pool databases and said global IP pool database based upon said reallocating.

5 74. The apparatus of claim 73 wherein

10 said local IP address pool includes a high watermark that indicates the maximum number of IP addresses used by said network edge device; and said determiner is further configured to ascertain whether said high watermark of a local address pool exceeds a high watermark limit and to indicate IP address pool should be reallocated to give more IP addresses to the network element associated with said high watermark when said high watermark exceeds said high watermark limit.

75. The apparatus of claim 74 wherein

15 each said local IP address pool further comprises a low watermark that indicates the minimum number of IP addresses used by said network edge device; and said determiner is further configured to ascertain whether said low watermark of said address pool exceeds a low watermark limit and to indicate one or more IP address pools should be reallocated to reclaim IP addresses from the network element associated with said low watermark when said low watermark exceeds said low watermark limit.

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76. The apparatus of claim 75 wherein said reallocator further configured to:

allocate an IP address from IP addresses reclaimed from other IP address pools when said high watermark exceeds said high watermark limit and when the number of

5 unallocated IP addresses is insufficient;

allocate an IP addresses from unallocated IP addresses when said high watermark exceeds said high watermark limit and when the number of unallocated IP addresses is sufficient; and

reallocating one or more IP address pools to reclaim IP addresses from a local IP

10 address pool when said high watermark is less than said high watermark limit and said low watermark is greater than said low watermark limit.

77. The apparatus of claim 73 wherein

each said local IP address pool further comprises a low watermark that indicates the

15 minimum number of IP addresses used by said network edge device; and

said determiner is further configured to ascertain whether said low watermark of said address pool exceeds a low watermark limit and to indicate one or more IP address pools should be reallocated to reclaim IP addresses from the network element associated with said low watermark when said low watermark exceeds

20 said low watermark limit.

78. The apparatus of claim 75 wherein

said low watermark is expressed as a percentage of allocated IP addresses; and

said high watermark is expressed as a percentage of allocated IP addresses.

79. The apparatus of claim 78 wherein said network operates according to a simple network management protocol (SNMP).

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80. The apparatus of claim 79 wherein  
said low watermark is stored in an expression MIB; and  
said high watermark is stored in an expression MIB.

10 81. An apparatus capable of managing Internet Protocol (IP) addresses on a data  
communications network, said apparatus comprising:  
a memory for storing a global IP address pool; and  
a global IP pool manager, comprising:  
an allocator capable of allocating a plurality of local IP address pools, each of said  
15 local IP address pools associated with a different network edge device  
capable of accepting connection requests requiring an IP address;  
a receiving interface capable of receiving a communication from said network  
edge device, said communication including an IP address usage summary;  
a determiner capable of determining whether one or more of said plurality of local  
20 IP address pools should be reallocated based upon said IP address usage data;  
a reallocator capable of reallocating one or more of said plurality of local IP  
address pools based upon said an indication from said determiner; and  
an updater capable of updating one or more of said local IP address pool  
databases and said global IP pool database based upon said reallocating.

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82. The apparatus of claim 81 wherein:

5       said local IP address pool includes a high watermark that indicates the maximum  
number of IP addresses used by said network edge device; and  
said determiner is further configured to ascertain whether said high watermark of a  
local address pool exceeds a high watermark limit and to indicate one or more IP  
address pools should be reallocated to give more IP addresses to the network  
element associated with said high watermark when said high watermark exceeds  
10       said high watermark limit.

83. The apparatus of claim 82 wherein

each said local IP address pool further comprises a low watermark that indicates the  
minimum number of IP addresses used by said network edge device; and  
15       said determiner is further configured to ascertain whether said low watermark of a  
said address pool exceeds a low watermark limit and to indicate one or more IP  
address pools should be reallocated to reclaim IP addresses from the network  
element associated with said low watermark when said low watermark exceeds  
said low watermark limit.

20

84. The apparatus of claim 83 wherein said reallocator is further configured to:

allocate an IP address from IP addresses reclaimed from other IP address pools when  
said high watermark exceeds said high watermark limit and when the number of  
unallocated IP addresses is insufficient;

allocate an IP addresses from unallocated IP addresses when said high watermark

exceeds said high watermark limit and when the number of unallocated IP  
addresses is sufficient; and

5        reallocate one or more IP address pools to reclaim IP addresses from a local IP  
address pool when said high watermark is less than said high watermark limit  
and said low watermark is greater than said low watermark limit.

85. The apparatus of claim 81 wherein

10      each said local IP address pool further comprises a low watermark that indicates the  
minimum number of IP addresses used by said network edge device; and  
said determiner is further configured to ascertain whether said low watermark of said  
address pool exceeds a low watermark limit and to indicate one or more IP  
address pools should be reallocated to reclaim IP addresses from the network  
15      element associated with said low watermark when said low watermark exceeds  
said low watermark limit.

86. The apparatus of claim 83 wherein

20      said low watermark is expressed as a percentage of allocated IP addresses; and  
said high watermark is expressed as a percentage of allocated IP addresses.

87. The apparatus of claim 86 wherein said network operates according to a simple  
network management protocol (SNMP).

88. The apparatus of claim 84 wherein  
said low watermark is stored in an expression MIB; and  
said high watermark is stored in an expression MIB.

5 89. An apparatus capable of managing Internet Protocol (IP) addresses on a data  
communications network, said apparatus comprising:  
a receiver capable of receiving a communication;  
an allocator capable of allocating an available IP address from a local IP address pool  
10 if said communication includes a connection request, said local IP address pool  
associated with a different network edge device capable of accepting connection  
requests;  
a determiner capable of determining whether said local IP address pool should be  
adjusted;  
15 an notifier capable of sending a alarm message to a global IP pool manager when said  
IP address pool should be adjusted; and  
a memory capable of storing an IP address allocation when said communication  
includes an IP address allocation.

20 90. The apparatus of claim 89 wherein  
said local IP address pool includes a high watermark that indicates the maximum  
number of IP addresses used by said network edge device; and  
said determiner is further configured to ascertain whether said high watermark of a  
local address pool exceeds a high watermark limit and to indicate one or more IP

address pools should be reallocated to give more IP addresses to said network edge device when said high watermark exceeds said high watermark limit.

5 91. The apparatus of claim 90 wherein

each said local IP address pool further comprises a low watermark that indicates the minimum number of IP addresses used by said network edge device; and said determiner is further configured to ascertain whether said low watermark of said address pool exceeds a low watermark limit and to indicate one or more IP

10 address pools should be reallocated to reclaim IP addresses from said network edge device when said low watermark exceeds said low watermark limit.

92. The apparatus of claim 91 wherein said reallocator is further configured to:

allocate an IP address from IP addresses reclaimed from other IP address pools when 15 said high watermark exceeds said high watermark limit and when the number of unallocated IP addresses is insufficient;

allocate an IP addresses from unallocated IP addresses when said high watermark exceeds said high watermark limit and when the number of unallocated IP addresses is sufficient; and

20 reallocate one or more IP address pools to reclaim IP addresses from said local IP address pool when said high watermark is less than said high watermark limit and said low watermark is greater than said low watermark limit.

93. The apparatus of claim 89 wherein

each said local IP address pool further comprises a low watermark that indicates the minimum number of IP addresses used by said network edge device; and

5 said determiner is further configured to ascertain whether said low watermark of said local address pool exceeds a low watermark limit and to indicate one or more IP address pools should be reallocated to reclaim IP addresses from the network element associated with said low watermark when said low watermark exceeds said low watermark limit.

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94. The apparatus of claim 91 wherein

said low watermark is expressed as a percentage of allocated IP addresses; and  
said high watermark is expressed as a percentage of allocated IP addresses.

15 95. The apparatus of claim 94 wherein said network operates according to a simple  
network management protocol (SNMP).

96. The apparatus of claim 95 wherein

said low watermark is stored in an expression MIB; and

20 said high watermark is stored in an expression MIB.